

JC780 U.S. PTO
03/31/00

4-3-00

A

Practitioner's Docket No. 50694

PATENT

Preliminary Classification:

Proposed Class:

Subclass:

NOTE: "All applicants are requested to include a preliminary classification on newly filed patent applications. The preliminary classification, preferably class and subclass designations, should be identified in the upper right-hand corner of the letter of transmittal accompanying the application papers, for example 'Proposed Class 2, subclass 129.'" M.P.E.P. § 601, 7th ed.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Box Patent Application
Assistant Commissioner for Patents
Washington, D.C. 20231

NEW APPLICATION TRANSMITTAL

Transmitted herewith for filing is the patent application of

Inventor(s): **Neil D. Brown, George A. Federman, Angelo Chirafisi and Gregory Lai**

WARNING: 37 C.F.R. § 1.41(a)(1) points out:

"(a) A patent is applied for in the name or names of the actual inventor or inventors.

"(1) The inventorship of a nonprovisional application is that inventorship set forth in the oath or declaration as prescribed by § 1.63, except as provided for in § 1.53(d)(4) and § 1.63(d). If an oath or declaration as prescribed by § 1.63 is not filed during the pendency of a nonprovisional application, the inventorship is that inventorship set forth in the application papers filed pursuant to § 1.53(b), unless a petition under this paragraph accompanied by the fee set forth in § 1.17(f) is filed supplying or changing the name or names of the inventor or inventors."

For (title): **TIN ELECTROLYTE**

CERTIFICATION UNDER 37 C.F.R. § 1.10*
(Express Mail label number is mandatory.)
(Express Mail certification is optional.)

I hereby certify that this New Application Transmittal and the documents referred to as attached therein are being deposited with the United States Postal Service on this date March 31, 2000, in an envelope as "Express Mail Post Office to Addressee," mailing Label Number EK493899015US, addressed to the: Assistant Commissioner for Patents, Washington, D.C. 20231.

Deanna M. Rivernider

(type or print name of person mailing paper)

Deanna M. Rivernider

Signature of person mailing paper

WARNING: Certificate of mailing (first class) or facsimile transmission procedures of 37 C.F.R. § 1.8 cannot be used to obtain a date of mailing or transmission for this correspondence.

***WARNING:** Each paper or fee filed by "Express Mail" **must** have the number of the "Express Mail" mailing label placed thereon prior to mailing. 37 C.F.R. § 1.10(b).

"Since the filing of correspondence under § 1.10 without the Express Mail mailing label thereon is an oversight that can be avoided by the exercise of reasonable care, requests for waiver of this requirement will **not** be granted on petition." Notice of Oct. 24, 1996, 60 Fed. Reg. 56,439, at 56,442.

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JC625 U.S. PTO
09/540359
03/31/00

09540359-033400

1. Type of Application

This new application is for a(n)

(check one applicable item below)

- ☒ Original (nonprovisional)
☐ Design
☐ Plant

WARNING: Do not use this transmittal for a completion in the U.S. of an International Application under 35 U.S.C. § 371(c)(4), unless the International Application is being filed as a divisional, continuation or continuation-in-part application.

WARNING: Do not use this transmittal for the filing of a provisional application.

NOTE: If one of the following 3 items apply, then complete and attach ADDED PAGES FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF A PRIOR U.S. APPLICATION CLAIMED and a NOTIFICATION IN PARENT APPLICATION OF THE FILING OF THIS CONTINUATION APPLICATION.

- ☐ Divisional.
☐ Continuation.
☐ Continuation-in-part (C-I-P).

2. Benefit of Prior U.S. Application(s) (35 U.S.C. §§ 119(e), 120, or 121)

NOTE: A nonprovisional application may claim an invention disclosed in one or more prior filed copending nonprovisional applications or copending international applications designating the United States of America. In order for a nonprovisional application to claim the benefit of a prior filed copending nonprovisional application or copending international application designating the United States of America, each prior application must name as an inventor at least one inventor named in the later filed nonprovisional application and disclose the named inventor's invention claimed in at least one claim of the later filed nonprovisional application in the manner provided by the first paragraph of 35 U.S.C. § 112. Each prior application must also be:

(i) An international application entitled to a filing date in accordance with PCT Article 11 and designating the United States of America; or

(ii) Complete as set forth in § 1.51(b); or

(iii) Entitled to a filing date as set forth in § 1.53(b) or § 1.53(d) and include the basic filing fee set forth in § 1.16; or

(iv) Entitled to a filing date as set forth in § 1.53(b) and have paid therein the processing and retention fee set forth in § 1.21(f) within the time period set forth in § 1.53(f).

37 C.F.R. § 1.78(a)(1).

NOTE: If the new application being transmitted is a divisional, continuation or a continuation-in-part of a parent case, or where the parent case is an International Application which designated the U.S., or benefit of a prior provisional application is claimed, then check the following item and complete and attach ADDED PAGES FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF PRIOR U.S. APPLICATION(S) CLAIMED.

WARNING: If an application claims the benefit of the filing date of an earlier filed application under 35 U.S.C. §§ 120, 121 or 365(c), the 20-year term of that application will be based upon the filing date of the earliest U.S. application that the application makes reference to under 35 U.S.C. §§ 120, 121 or 365(c). (35 U.S.C. § 154(a)(2) does not take into account, for the determination of the patent term, any application on which priority is claimed under 35 U.S.C. §§ 119, 365(a) or 365(b).) For a c-i-p application, applicant should review whether any claim in the patent that will issue is supported by an earlier application and, if not, the applicant should consider canceling the reference to the earlier filed application. The term of a patent is not based on a claim-by-claim approach. See Notice of April 14, 1995, 60 Fed. Reg. 20,195, at 20,205.

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OFFICE OF THE SECRETARY

- ☐ Declaration of Biological Deposit
- ☐ Submission of "Sequence Listing," computer readable copy and/or amendment pertaining thereto for biotechnology invention containing nucleotide and/or amino acid sequence.
- ☐ Authorization of Attorney(s) to Accept and Follow Instructions from Representative
- ☐ Special Comments
- ☐ Other

5. Declaration or oath (including power of attorney)

NOTE: A newly executed declaration is not required in a continuation or divisional application provided that the prior nonprovisional application contained a declaration as required, the application being filed is by all or fewer than all the inventors named in the prior application, there is no new matter in the application being filed, and a copy of the executed declaration filed in the prior application (showing the signature or an indication thereon that it was signed) is submitted. The copy must be accompanied by a statement requesting deletion of the names of person(s) who are not inventors of the application being filed. If the declaration in the prior application was filed under § 1.47, then a copy of that declaration must be filed accompanied by a copy of the decision granting § 1.47 status or, if a nonsigning person under § 1.47 has subsequently joined in a prior application, then a copy of the subsequently executed declaration must be filed. See 37 C.F.R. §§ 1.63(d)(1)-(3).

NOTE: A declaration filed to complete an application must be executed, identify the specification to which it is directed, identify each inventor by full name including family name and at least one given name, without abbreviation together with any other given name or initial, and the residence, post office address and country or citizenship of each inventor, and state whether the inventor is a sole or joint inventor. 37 C.F.R. § 1.63(a)(1)-(4).

NOTE: "The inventorship of a nonprovisional application is that inventorship set forth in the oath or declaration as prescribed by § 1.62, except as provided for in § 1.53(d)(4) and § 1.63(d). If an oath or declaration as prescribed by § 1.63 is not filed during the pendency of a nonprovisional application, the inventorship is that inventorship set forth in the application papers filed pursuant to § 1.53(b), unless a petition under this paragraph accompanied by the fee set forth in § 1.17(f) is filed supplying or changing the name or names of the inventor or inventors." 37 C.F.R. § 1.41(a)(1).

☒ Enclosed

Executed by

(check all applicable boxes)

☒ inventor(s).

☐ legal representative of inventor(s).
37 C.F.R. §§ 1.42 or 1.43.

☐ joint inventor or person showing a proprietary interest on behalf of inventor who refused to sign or cannot be reached.

☐ This is the petition required by 37 C.F.R. § 1.47 and the statement required by 37 C.F.R. § 1.47 is also attached. See item 13 below for fee.

☐ Not Enclosed.

NOTE: Where the filing is a completion in the U.S. of an International Application or where the completion of the U.S. application contains subject matter in addition to the International Application, the application may be treated as a continuation or continuation-in-part, as the case may be, utilizing ADDED PAGE FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF PRIOR U.S. APPLICATION CLAIMED.

☐ Application is made by a person authorized under 37 C.F.R. § 1.41(c) on behalf of all the above named inventor(s).

WARNING: When the last day of pendency of a provisional application falls on a Saturday, Sunday, or Federal holiday within the District of Columbia, any nonprovisional application claiming benefit of the provisional application must be filed prior to the Saturday, Sunday, or Federal holiday within the District of Columbia. See 37 C.F.R. § 1.78(a)(3).

- ☐ The new application being transmitted claims the benefit of prior U.S. application(s). Enclosed are ADDED PAGES FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF PRIOR U.S. APPLICATION(S) CLAIMED.

3. Papers Enclosed

- A. Required for filing date under 37 C.F.R. § 1.53(b) (Regular) or 37 C.F.R. § 1.153 (Design) Application

14 Pages of specification

2 Pages of claims

1 Sheets of drawing

WARNING: **DO NOT** submit original drawings. A high quality copy of the drawings should be supplied when filing a patent application. The drawings that are submitted to the Office must be on strong, white, smooth, and non-shiny paper and meet the standards according to § 1.84. If corrections to the drawings are necessary, they should be made to the original drawing and a high-quality copy of the corrected original drawing then submitted to the Office. Only one copy is required or desired. For comments on proposed then-new 37 C.F.R. § 1.84, see Notice of March 9, 1988 (1990 O.G. 57-62).

NOTE: "Identifying indicia, if provided, should include the application number or the title of the invention, inventor's name, docket number (if any), and the name and telephone number of a person to call if the Office is unable to match the drawings to the proper application. This information should be placed on the back of each sheet of drawing a minimum distance of 1.5 cm. (5/8 inch) down from the top of the page . . ." 37 C.F.R. § 1.84(c)).

(complete the following, if applicable)

- ☐ The enclosed drawing(s) are photograph(s), and there is also attached a "PETITION TO ACCEPT PHOTOGRAPH(S) AS DRAWING(S)." 37 C.F.R. § 1.84(b).
- ☐ formal
- ☐ informal

B. Other Papers Enclosed

4 Pages of declaration and power of attorney

1 Pages of abstract

 Other

4. Additional papers enclosed

- ☐ Amendment to claims
- ☐ Cancel in this applications claims _____ before calculating the filing fee. (At least one original independent claim must be retained for filing purposes.)
- ☐ Add the claims shown on the attached amendment. (Claims added have been numbered consecutively following the highest numbered original claims.)
- ☐ Preliminary Amendment
- ☒ Information Disclosure Statement (37 C.F.R. § 1.98)
- ☒ Form PTO-1449 (PTO/SB/08A and 08B)
- ☒ Citations

(The declaration or oath, along with the surcharge required by 37 C.F.R. § 1.16(e) can be filed subsequently).

- ☐ Showing that the filing is authorized.
(not required unless called into question. 37 C.F.R. § 1.41(d))

6. Inventorship Statement

WARNING: If the named inventors are each not the inventors of all the claims an explanation, including the ownership of the various claims at the time the last claimed invention was made, should be submitted.

The inventorship for all the claims in this application are:

- ☐ The same.

or

- ☐ Not the same. An explanation, including the ownership of the various claims at the time the last claimed invention was made,
☐ is submitted.
☐ will be submitted.

7. Language

NOTE: An application including a signed oath or declaration may be filed in a language other than English. An English translation of the non-English language application and the processing fee of \$130.00 required by 37 C.F.R. § 1.17(k) is required to be filed with the application, or within such time as may be set by the Office. 37 C.F.R. § 1.52(d).

- ☒ English
☐ Non-English
☐ The attached translation includes a statement that the translation is accurate. 37 C.F.R. § 1.52(d).

8. Assignment

- ☒ An assignment of the invention to Shipley Company, L.L.C. of
Marlborough, Massachusetts 01752
☒ is attached. A separate ☐ "COVER SHEET FOR ASSIGNMENT (DOCUMENT) ACCOMPANYING NEW PATENT APPLICATION" or ☒ FORM PTO 1595 is also attached.
☐ will follow.

NOTE: "If an assignment is submitted with a new application, send two separate letters—one for the application and one for the assignment." Notice of May 4, 1990 (1114 O.G. 77-78).

WARNING: A newly executed "CERTIFICATE UNDER 37 C.F.R. § 3.73(b)" must be filed when a continuation-in-part application is filed by an assignee. Notice of April 30, 1993, 1150 O.G. 62-64.

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004620-03044560

9. Certified Copy

Certified copy(ies) of application(s)

Country	Appln. No.	Filed
Country	Appln. No.	Filed
Country	Appln. No.	Filed

from which priority is claimed

- ☐ is (are) attached.
☐ will follow.

NOTE: The foreign application forming the basis for the claim for priority must be referred to in the oath or declaration. 37 C.F.R. § 1.55(a) and 1.63.

NOTE: This item is for any foreign priority for which the application being filed directly relates. If any parent U.S. application or International Application from which this application claims benefit under 35 U.S.C. § 120 is itself entitled to priority from a prior foreign application, then complete item 18 on the ADDED PAGES FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF PRIOR U.S. APPLICATION(S) CLAIMED.

10. Fee Calculation (37 C.F.R. § 1.16)

- A. ☒ Regular application

CLAIMS AS FILED			
Number filed	Number Extra	Rate	Basic Fee 37 C.F.R. § 1.16(a) \$690.00
Total			
Claims (37 C.F.R. § 1.16(c))	17 - 20 =	×	\$ 18.00
Independent			
Claims (37 C.F.R. § 1.16(b))	2 - 3 =	×	\$ 78.00
Multiple dependent claim(s),			
if any (37 C.F.R. § 1.16(d))		+	\$260.00

- ☐ Amendment cancelling extra claims is enclosed.
☐ Amendment deleting multiple-dependencies is enclosed.
☐ Fee for extra claims is not being paid at this time.

NOTE: If the fees for extra claims are not paid on filing they must be paid or the claims cancelled by amendment, prior to the expiration of the time period set for response by the Patent and Trademark Office in any notice of fee deficiency. 37 C.F.R. § 1.16(d).

Filing Fee Calculation \$ 690.00

- B. ☐ Design application
(\$310.00—37 C.F.R. § 1.16(f))

Filing Fee Calculation

\$

- C. ☐ Plant application
(\$480.00—37 C.F.R. § 1.16(g))

Filing fee calculation

\$ _____

11. Small Entity Statement(s)

- ☐ Statement(s) that this is a filing by a small entity under 37 C.F.R. § 1.9 and 1.27 is (are) attached.

WARNING: "Status as a small entity must be specifically established in each application or patent in which the status is available and desired. Status as a small entity in one application or patent does not affect any other application or patent, including applications or patents which are directly or indirectly dependent upon the application or patent in which the status has been established. The refiling of an application under § 1.53 as a continuation, division, or continuation-in-part (including a continued prosecution application under § 1.53(d)), or the filing of a reissue application requires a new determination as to continued entitlement to small entity status for the continuing or reissue application. A nonprovisional application claiming benefit under 35 U.S.C. § 119(e), 120, 121, or 365(c) of a prior application, or a reissue application may rely on a statement filed in the prior application or in the patent if the nonprovisional application or the reissue application includes a reference to the statement in the prior application or in the patent or includes a copy of the statement in the prior application or in the patent and status as a small entity is still proper and desired. The payment of the small entity basic statutory filing fee will be treated as such a reference for purposes of this section." 37 C.F.R. § 1.28(a)(2).

WARNING: "Small entity status must not be established when the person or persons signing the . . . statement can *unequivocally* make the required self-certification." M.P.E.P., § 509.03, 6th ed., rev. 2, July 1996 (emphasis added).

(complete the following, if applicable)

- ☐ Status as a small entity was claimed in prior application
_____ / _____, filed on _____, from which benefit
is being claimed for this application under:
35 U.S.C. § ☐ 119(e),
☐ 120,
☐ 121,
☐ 365(c),

and which status as a small entity is still proper and desired.

- ☐ A copy of the statement in the prior application is included.

Filing Fee Calculation (50% of A, B or C above)

\$ _____

NOTE: Any excess of the full fee paid will be refunded if small entity status is established and a refund request are filed within 2 months of the date of timely payment of a full fee. The two-month period is not extendable under § 1.136. 37 C.F.R. § 1.28(a).

12. Request for International-Type Search (37 C.F.R. § 1.104(d))

(complete, if applicable)

- ☐ Please prepare an international-type search report for this application at the time when national examination on the merits takes place.

13. Fee Payment Being Made at This Time

☐ Not Enclosed

☐ No filing fee is to be paid at this time.

(This and the surcharge required by 37 C.F.R. § 1.16(e) can be paid subsequently.)

☒ Enclosed

☒ Filing fee \$ 690.00

☒ Recording assignment
(\$40.00; 37 C.F.R. § 1.21(h))
(See attached "COVER SHEET FOR
ASSIGNMENT ACCOMPANYING NEW
APPLICATION".) \$ 40.00

☐ Petition fee for filing by other than all the
inventors or person on behalf of the inventor
where inventor refused to sign or cannot be
reached
(\$130.00; 37 C.F.R. §§ 1.47 and 1.17(l)) \$ _____

☐ For processing an application with a
specification in
a non-English language
(\$130.00; 37 C.F.R. §§ 1.52(d) and 1.17(k)) \$ _____

☐ Processing and retention fee
(\$130.00; 37 C.F.R. §§ 1.53(d) and 1.21(l)) \$ _____

☐ Fee for international-type search report
(\$40.00; 37 C.F.R. § 1.21(e)) \$ _____

NOTE: 37 C.F.R. § 1.21(f) establishes a fee for processing and retaining any application that is abandoned for failing to complete the application pursuant to 37 C.F.R. § 1.53(f) and this, as well as the changes to 37 C.F.R. §§ 1.53 and 1.78(a)(1), indicate that in order to obtain the benefit of a prior U.S. application, either the basic filing fee must be paid, or the processing and retention fee of § 1.21(f) must be paid, within 1 year from notification under § 53(f).

Total fees enclosed \$ 730.00

14. Method of Payment of Fees

☒ Check in the amount of \$ 730.00

☐ Charge Account No. _____ in the amount of
\$ _____

A duplicate of this transmittal is attached.

NOTE: Fees should be itemized in such a manner that it is clear for which purpose the fees are paid. 37 C.F.R. § 1.22(b).

15. Authorization to Charge Additional Fees

WARNING: If no fees are to be paid on filing, the following items should not be completed.

WARNING: Accurately count claims, especially multiple dependent claims, to avoid unexpected high charges, if extra claim charges are authorized.

- ☒ The Commissioner is hereby authorized to charge the following additional fees by this paper and during the entire pendency of this application to Account No. 04-1105:

☒ 37 C.F.R. § 1.16(a), (f) or (g) (filing fees)

☒ 37 C.F.R. § 1.16(b), (c) and (d) (presentation of extra claims)

NOTE: Because additional fees for excess or multiple dependent claims not paid on filing or on later presentation must only be paid or these claims cancelled by amendment prior to the expiration of the time period set for response by the PTO in any notice of fee deficiency (37 C.F.R. § 1.16(d)), it might be best not to authorize the PTO to charge additional claim fees, except possibly when dealing with amendments after final action.

☒ 37 C.F.R. § 1.16(e) (surcharge for filing the basic filing fee and/or declaration on a date later than the filing date of the application)

☒ 37 C.F.R. § 1.17(a)(1)-(5) (extension fees pursuant to § 1.136(a)).

☒ 37 C.F.R. § 1.17 (application processing fees)

NOTE: ". . . A written request may be submitted in an application that is an authorization to treat any concurrent or future reply, requiring a petition for an extension of time under this paragraph for its timely submission, as incorporating a petition for extension of time for the appropriate length of time. An authorization to charge all required fees, fees under § 1.17, or all required extension of time fees will be treated as a constructive petition for an extension of time in any concurrent or future reply requiring a petition for an extension of time under this paragraph for its timely submission. Submission of the fee set forth in § 1.17(a) will also be treated as a constructive petition for an extension of time in any concurrent reply requiring a petition for an extension of time under this paragraph for its timely submission." 37 C.F.R. § 1.136(a)(3).

☐ 37 C.F.R. § 1.18 (issue fee at or before mailing of Notice of Allowance, pursuant to 37 C.F.R. § 1.311(b))

NOTE: Where an authorization to charge the issue fee to a deposit account has been filed before the mailing of a Notice of Allowance, the issue fee will be automatically charged to the deposit account at the time of mailing the notice of allowance. 37 C.F.R. § 1.311(b).

NOTE: 37 C.F.R. § 1.28(b) requires "Notification of any change in status resulting in loss of entitlement to small entity status must be filed in the application . . . prior to paying, or at the time of paying, . . . the issue fee. . . ." From the wording of 37 C.F.R. § 1.28(b), (a) notification of change of status must be made even if the fee is paid as "other than a small entity" and (b) no notification is required if the change is to another small entity.

16. Instructions as to Overpayment

NOTE: "... Amounts of twenty-five dollars or less will not be returned unless specifically requested within a reasonable time, nor will the payer be notified of such amounts; amounts over twenty-five dollars may be returned by check or, if requested, by credit to a deposit account." 37 C.F.R. § 1.26(a).

- ☒ Credit Account No. 04-1105
☐ Refund

007620 5920960

Reg. No. 42,378

Tel. No. (508) 229-7545

Customer No.



SIGNATURE OF PRACTITIONER

S. Matthew Cairns
(type or print name of attorney)
c/o Dike, Bronstein, Roberts & Cushman, LLP
130 Water Street

P.O. Address

Boston, MA 02109

☒ **Incorporation by reference of added pages**

(check the following item if the application in this transmittal claims the benefit of prior U.S. application(s) (including an international application entering the U.S. stage as a continuation, divisional or C-I-P application) and complete and attach the ADDED PAGES FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF PRIOR U.S. APPLICATION(S) CLAIMED)

- ☐ Plus Added Pages for New Application Transmittal Where Benefit of Prior U.S. Application(s) Claimed

Number of pages added _____

- ☒ Plus Added Pages for Papers Referred to in Item 4 Above

Number of pages added _____

- ☐ Plus added pages deleting names of inventor(s) named in prior application(s) who is/are no longer inventor(s) of the subject matter claimed in this application.

Number of pages added _____

- ☒ Plus "Assignment Cover Letter Accompanying New Application"

Number of pages added 3

☐ **Statement Where No Further Pages Added**

(if no further pages form a part of this Transmittal, then end this Transmittal with this page and check the following item)

- ☐ This transmittal ends with this page.

Express Mail Label No. EK493899015US
Docket No. 50694

U.S. PATENT APPLICATION

Title: **TIN ELECTROLYTE**

Inventors: Neil D. BROWN
George A. FEDERMAN
Angelo CHIRAFISI
Gregory LAI

Attorney: Peter F. Corless (Reg. 33860)
Dike, Bronstein, Roberts & Cushman LLP
130 Water Street
Boston, MA 02109
Telephone: (617) 523-3400

2017.03.03 15:04:00

TIN ELECTROLYTE

Background of the Invention

This invention relates generally to the field of plating metal on a substrate. In particular, the present invention relates to electrolyte compositions and methods for depositing tin.

Electroplating baths for depositing tin, lead, or their alloys have been used for many years in electroplating equipment. High speed electroplating equipment and processes are well-known in the industry and generally consist of directing the work to be plated into the electroplating cell from one end, allowing the work to proceed through the electroplating cell and exit thereafter the cell at the other end. The electroplating solution is removed or overflows the electroplating cell into a reservoir and the solution is pumped from the reservoir back into the electroplating cell to provide vigorous agitation and solution circulation. Many variations of these electroplating cells can exist, but the general features are as described.

There are a number of desirable features that the electroplating solution should possess for improved operation in this type of equipment or processing, as follows. The solution must be able to electroplate the desired deposit at the high speeds required. The solution must deposit tin which meets the solderability or reflow requirements of the specific application. The solution should be stable and the additives in the solution must withstand exposure to the strong acid solution as well as to the introduction of air, which would take place as a result of the vigorous solution movement in high speed plating machines. The solution should remain clear and free from turbidity, even at elevated temperatures such as 120 to 130° F or higher. Due to the high current densities involved it is often advantageous to operate these solutions at an elevated temperature. The additives used must be of a type that will not turn the solution turbid at such elevated temperatures.

Due to the vigorous solution movement and solution mixing with air in such high speed plating processes, there is a strong tendency to produce a foam which is detrimental to the electroplating process. Under extreme conditions, this foam can build up in the

reservoir tank with resultant overflow onto the floor, thereby losing a large quantity of solution to the waste stream. Foam can also interfere with the operation of the pump that is being used to generate agitation. Arcing between the anode and cathode is also possible due to the presence of foam. Thus, the additives used in the electroplating solutions should not generate foam in the plating equipment.

Many electrolytes have been proposed for electroplating tin, lead, and tin/lead alloys. For example, U.S. Patent No. 5,174,887 (Federman et al.) discloses a process for the high speed electroplating of tin having as a surfactant an alkylene oxide condensation product of an organic compound having at least one hydroxy group and 20 carbon atoms or less. The organic compounds include an aliphatic hydrocarbon of between 1 and 7 carbon atoms, an unsubstituted aromatic compound or an alkylated aromatic compound having 6 carbon atoms or less in the alkyl moiety.

U.S. Patent No. 5,871,631 (Ichiba et al.) discloses a divalent tin salt of an organic sulfonic acid, an antioxidant, and a brightening agent having an additive ingredient (A) prepared by adding propylene oxide to polyoxyethylene glycol and having an average molecular weight ranging from 3000 to 18000; and an additive ingredient (B) prepared by adding propylene oxide to polyoxyethylene glycol and having an average molecular weight ranging from 300 to 1500; where the weight ratio of (A) to (B) is from 97/3 to 40/60.

During use, a high speed tinplate line may slow down, such as when a new metal coil is welded to the end of the metal strip that is being plated. During such slow down periods the rate at which the metal substrate passes through the electroplating bath slows down. Theoretically, in order to maintain a consistent tin or tin-alloy deposit thickness, i.e. coating weight, the plating bath must be run at a lower current density. However, current tin and tin-alloy high speed electroplating baths, including those discussed above, fail to produce a consistent appearance of tin or tin-alloy over a sufficiently wide current density range to allow for such slow down periods.

007620-634360

There is thus a continuing need for plating baths that will deposit tin or tin-alloys over a wide current density range while maintaining a uniform deposit appearance over the current density range, particularly for use in high speed plating systems.

Summary of the Invention

It has been surprisingly found that tin or tin-alloy may be uniformly deposited over a wide current density range using the electrolyte compositions of the present invention. It has been further surprisingly found that the electrolyte compositions of the present invention plate tin or tin-alloy at high current densities with low metal concentrations, while producing a uniform deposit appearance over the entire current density range.

In a first aspect, the present invention provides an electrolyte composition for depositing tin or tin-alloy on a substrate, including one or more tin compounds, one or more acidic electrolytes, one or more alkylene oxide compounds, one or more polyalkylene glycols and optionally one or more additives.

In a second aspect, the present invention provides a method for depositing tin or tin-alloy on a substrate including the steps of contacting the substrate with the electrolyte composition described above and applying a sufficient current density to the electrolyte composition to deposit the tin or tin-alloy on the substrate.

In a third aspect, the present invention provides a substrate having a tin or tin-alloy deposited thereon according to the method described above.

In a fourth aspect, the present invention provides a method for high speed electroplating of tin or tin-alloys including the steps of: a) utilizing high speed electroplating equipment comprising an electroplating cell; an overflow reservoir adjacent the cell; means for returning solution from the reservoir to the electroplating cell; means for directing a substrate to be plated from an entry point at one end of the cell to an exit at a second end of the cell; b) introducing an electrolyte including a basis solution of one or more tin compounds, one or more acidic electrolytes, one or more alkylene oxide

compounds, one or more polyalkylene glycols and optionally one or more additive; and c) continuously electroplating substrates with tin or tin-alloy at a sufficient current density and at a sufficient temperature for high speed electroplating as the substrates pass through the electroplating solution within the cell.

Brief Description of the Drawing

FIG. 1 is a cross-sectional view of an electroplating cell for depositing tin on a metal strip.

Detailed Description of the Invention

As used throughout this specification, the following abbreviations shall have the following meanings, unless the context clearly indicates otherwise: ° C = degrees Centigrade; ° F = degrees Fahrenheit; g = gram; L = liter; mL = milliliter; wt% = percent by weight; ppm = parts per million; " = inches; cm = centimeters; rpm = revolutions per minute; and ASF = amps per square foot. The terms "depositing" and "plating" are used interchangeably throughout this specification. "Halide" refers to fluoride, chloride, bromide and iodide. "Alkyl" refers to linear, branched and cyclic alkyl. All percentages are by weight, unless otherwise noted. All numerical ranges are inclusive and combinable.

The electrolyte compositions of the present invention include one or more tin compounds, one or more acidic electrolytes, one or more alkylene oxide compounds, one or more polyalkylene glycols and optionally one or more additives to enhance the efficiency and/or quality of the plating.

The one or more tin compounds useful in the present invention are any solution soluble tin compound. Suitable tin compounds include, but are not limited to salts, such as tin halides, tin sulfates, tin alkane sulfonate such as tin methane sulfonate, tin aryl sulfonate such as tin phenyl sulfonate and tin toluene sulfonate, tin alkanol sulfonate, and the like. When tin halide is used, it is preferred that the halide is chloride. It is preferred

that the tin compound is tin sulfate, tin chloride, tin alkane sulfonate or tin aryl sulfonate, and more preferably tin sulfate or tin methane sulfonate. The tin compounds useful in the present invention are generally commercially available from a variety of sources and may be used without further purification. Alternatively, the tin compounds useful in the present invention may be prepared by methods known in the literature.

The amount of tin compound useful in the electrolyte compositions of the present invention is any amount that provides a tin content typically in the range of 5 to 100 g/L, and preferably 10 to 70 g/L. When the compositions of the present invention are used in a low speed plating process, the amount of tin present in the electrolyte composition is typically in the range of 5 to 40 g/L, and preferably 10 to 20 g/L. When the compositions of the present invention are used in a high speed plating process, the amount of tin present in the electrolyte composition is typically in the range of 20 to 100 g/L, and preferably 50 to 70 g/L. When the compositions of the present invention are used in high speed tin plating of steel, the amount of tin is typically in the range of 5 to 50 g/L, and preferably 10 to 30 g/L. Mixtures of tin compounds may also be used advantageously in the present invention, provided that the total amount of tin is in the range of from 5 to 100 g/L.

Any acidic electrolyte that is solution soluble and does not otherwise adversely affect the electrolyte composition may be used advantageously in the present invention. Suitable acidic electrolytes include, but are not limited to alkane sulfonic acids, such as methane sulfonic acid, aryl sulfonic acids such as phenyl sulfonic acid or toluene sulfonic acid, sulfuric acid, sulfamic acid, hydrochloric acid, hydrobromic acid and fluoroboric acid. Mixtures of acidic electrolytes are particularly useful, such as, but not limited to, mixtures of alkane sulfonic acids and sulfuric acid. Thus, more than one acidic electrolyte may be used advantageously in the present invention. The acidic electrolytes useful in the present invention are generally commercially available and may be used without further purification. Alternatively, the acidic electrolytes may be prepared by methods known in the literature.

Typically, the amount of acidic electrolyte is in the range of 10 to 400 g/L, and preferably 100 to 200 g/L. When the compositions of the present invention are used in the high speed tin plating of steel, the acidic electrolyte is typically present in an amount in the range of 20 to 80 g/L, and preferably 30 to 60 g/L. It is preferred that when the tin compound is a halide that the acidic electrolyte is the corresponding acid. For example, when tin chloride is used in the present invention, it is preferred that the acidic electrolyte is hydrochloric acid.

The one or more alkylene oxide compounds useful in the present invention are any which yield deposits having good solderability, good matte or lustrous finish with satisfactory grain refinement, are stable in the acidic electroplating bath, electroplate at high speeds, are substantially low foaming, and provide a cloud point of the bath above about 110° F (43° to 44° C). It is preferred that the alkylene oxide compounds provide no foam to the bath during the electroplating process. Suitable alkylene oxide compounds include, but are not limited to, ethylene oxide / propylene oxide ("EO/PO") copolymers, alkylene oxide condensation products of an organic compound having at least one hydroxy group and 20 carbon atoms or less, compounds prepared by adding oxypropylene to polyoxyethylene glycol, and the like. Typically, the EO/PO copolymers have an average molecular weight in the range of from about 500 to about 10,000, and preferably from about 1000 to about 5000. It is preferred that the alkylene oxide compound is an EO/PO copolymer.

Suitable alkylene oxide condensation products of an organic compound having at least one hydroxy group and 20 carbon atoms or less include those having an aliphatic hydrocarbon of from one to seven carbon atoms, an unsubstituted aromatic compound or an alkylated aromatic compound having about six carbon atoms or less in the alkyl moiety, such as those disclosed in U.S. Patent No. 5,174,887, herein incorporated by reference to the extent it teaches the preparation and use of these compounds. The aliphatic alcohols may be saturated or unsaturated. Suitable aromatic compounds are those having up to two aromatic rings. The aromatic alcohols typically have up to 20 carbon atoms prior to derivatization with ethylene oxide ("EO"). Such aliphatic and aromatic alcohols may be further substituted, such as with sulfate or sulfonate groups.

Such suitable alkylene oxide compounds include, but are not limited to: ethyloxylated polystyrenated phenol having 12 moles of EO, ethyloxylated butanol having 5 moles of EO, ethyloxylated butanol having 16 moles of EO, ethyloxylated butanol having 8 moles of EO, ethyloxylated octanol having 12 moles of EO, ethyloxylated beta-naphthol having 13 moles of EO, ethyloxylated bisphenol A having 10 moles of EO, ethyloxylated sulfated bisphenol A having 30 moles of EO and ethyloxylated bisphenol A having 8 moles of EO.

Typically, the one or more alkylene oxide compounds are present in the electrolyte compositions of the present invention in an amount of from 0.1 to 15 mL/L, and preferably 0.5 to 10 mL/L.

The one or more polyalkylene glycols useful in the present invention are any which are compatible with the electrolyte composition, yield deposits having good solderability, good matte or lustrous finish with satisfactory grain refinement, are stable in the acidic electroplating bath, electroplate at high speeds, are substantially low foaming, and provide a cloud point of the bath above about 110° F (43° to 44° C). It is preferred that the alkylene oxide compounds provide no foam to the bath during the electroplating process. Suitable polyalkylene glycols include, but are not limited to, polyethylene glycol and polypropylene glycol, and preferably polyethylene glycol. Such polyalkylene glycols are generally commercially available from a variety of sources and may be used without further purification.

Typically, the polyalkylene glycols useful in the present invention are those having an average molecular weight in the range of from about 200 to about 100,000, and preferably from about 900 to about 20,000. Such polyalkylene glycols are present in the electrolyte compositions of the present invention in an amount of from about 0.1 to about 15 g/L, preferably from about 0.25 to about 10 g/L, and more preferably from about 0.5 to about 8 g/L.

It will be appreciated by those skilled in the art that one or more other metal compounds may be combined with the electrolyte composition of the present invention. Such other metal compounds are necessary for the plating of tin-alloys. Suitable other

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metals include, but are not limited to, lead, nickel, copper, bismuth, zinc, silver, indium and the like. The other metal compounds useful in the present invention are any which provide the metal to the electrolyte composition in a soluble form. Thus, the metal compounds include, but are not limited to, salts, such as metal halides, metal sulfates, metal alkane sulfonate such as metal methane sulfonate, metal aryl sulfonate such as metal phenyl sulfonate and metal toluene sulfonate, metal alkanol sulfonate, and the like. The choice of other metal compound and the amount of such other metal compound present in the electrolyte composition depends upon the tin-alloy to be deposited, and is well known to those skilled in the art.

It will be appreciated by those skilled in the art that one or more other additives may be combined with the electrolyte composition of the present invention, such as reducing agents, grain refiners such as hydroxy aromatic compounds and other wetting agents, brightening agents and the like. Mixtures of additives may also be used in the present invention.

Reducing agents may be added to the electrolyte composition of the present invention to assist in keeping the tin in a soluble, divalent state. Suitable reducing agents include, but are not limited to, hydroquinone and hydroxylated aromatic compounds, such as resorcinol, catechol, and the like. Such reducing agents are disclosed in U.S. Patent No. 4,871,429, herein incorporated by reference to the extent it teaches the preparation and use of such compounds. The amount of such reducing agent is well known to those skilled in the art, but is typically in the range of from about 0.1 g/L to about 5 g/L.

Bright deposits may be obtained by adding brighteners to the electrolyte compositions of the present invention. Such brighteners are well known to those skilled in the art. Suitable brighteners include, but are not limited to aromatic aldehydes such as chlorobenzaldehyde, derivatives of aromatic aldehydes such as benzal acetone, and aliphatic aldehydes such as acetaldehyde or glutaraldehyde. Such brighteners are typically added to the compositions of the present invention to improve the appearance and reflectivity of the deposit. Typically, brighteners are used at an amount of 0.5 to 3 g/L, and preferably 1 to 2 g/L.

It will be appreciated by those skilled in the art that hydroxy aromatic compounds or other wetting agents may be added to the electrolyte compositions of the present invention to provide further grain refinement. Such grain refiners may be added to the electrolyte composition of the present invention to further improve deposit appearance and operating current density range. Suitable other wetting agents include, but are not limited to: alkoxylates, such as the polyethoxylated amines JEFFAMINE T-403 or TRITON RW, or sulfated alkyl ethoxylates, such as TRITON QS-15, and gelatin or gelatin derivatives. The amounts of such grain refiners useful in the present invention are well known to those skilled in the art and typically are in the range of 0.01 to 20 mL/L, preferably 0.5 to 8 mL/L, and more preferably 1 to 5 mL/L.

Which optional additives, if any, are added to the electrolyte compositions of the present invention depends upon the results and types of deposits desired. It will be clear to one skilled in the art which additives and in what amounts are needed to achieve the desired finished deposit.

Electroplating baths containing the electrolyte compositions of the present invention are typically prepared by adding to a vessel one or more acidic electrolytes, followed by one or more tin compounds, one or more alkylene oxide compounds, one or more polyalkylene glycols and then one or more other additives. Other orders of addition of the components of the compositions of the present invention may be used. Once the bath is prepared, undesired material is removed, such as by filtration, and then water is added to adjust the final volume of the bath. The bath may be agitated by any known means, such as stirring, pumping, sparging or jetting the solution, for increased plating speed.

The electrolyte compositions of the present invention and plating baths prepared therefrom typically are acidic, i.e. having a pH of less than 7, typically less than 1. An advantage of the electrolyte compositions of the present invention is that pH adjustment of the electroplating bath is not necessary.

The electrolyte compositions of the present invention are useful in any plating method where a tin or tin-alloy deposit is desired. Suitable plating methods include, but

are not limited to barrel plating, rack plating and high speed plating. A tin or tin-alloy deposit may be plated on a substrate by the steps of contacting the substrate with the electrolyte composition described above and passing a current through the electrolyte to deposit the tin or tin-alloy on the substrate. Any substrate that can be electrolytically plated with a metal is suitable for plating according to the present invention. Suitable substrates include, but are not limited to: steel, copper, copper alloys, nickel, nickel alloys, nickel-iron containing materials, electronic components, plastics, and the like. Suitable plastics include plastic laminates, such as printing wiring boards, particularly copper clad printed wiring boards. The electrolyte compositions of the present invention are particularly suitable for electroplating of steel, particularly in high speed electroplating processes.

The substrate to be plated may be contacted with the electrolyte composition in any manner known in the art. Typically, the substrate is placed in a bath containing the electrolyte composition of the present invention.

Typically, the current density used to plate the tin or tin-alloy of the present invention is in the range of, but not limited to, 1 to 2000 ASF. When a low speed electroplating process is used, the current density is typically in the range of 1 to 40 ASF, and preferably 1 to 30 ASF. When a high speed electroplating process is used, the current density is typically in the range of 50 to 2000 ASF, and preferably 100 to 1500 ASF. For example, when the electrolyte compositions of the present invention are used to deposit tin on steel in a high speed plating processes, a suitable current density is 100 to 600 ASF, resulting in a tin deposit having a thickness of typically from 5 to 100 microinches.

Typically, the tin or tin-alloy of the present invention may be deposited at a temperature in the range of, but not limited to, 60° to 150° F (15° to 66° C) or higher, and preferably 70° to 125° F (21° to 52° C), and more preferably 75° to 120° F (23° to 49° C).

In general, the length of time a substrate remains in a plating bath containing the electrolyte compositions of the present invention is not critical. Longer times typically result in thicker deposits while shorter times typically result in thinner deposits, for a

given temperature and current density. Thus, the length of time a substrate remains in a plating bath may be used to control the thickness of the resulting deposit.

The electrolyte compositions of the present invention are particularly useful for depositing tin, but may also be used to deposit tin-alloys containing 60 to 99.5 wt% tin and 0.5 to 40 wt% other metals, based on the weight of the alloy, as measured by either atomic adsorption spectroscopy ("AAS") or inductively coupled plasma ("ICP").

A further advantage of the electrolyte compositions of the present invention is that they may be successfully used to deposit tin or tin-alloy in a high speed electroplating process. The term "high speed electroplating" refers to those processes which operate at a current density about 50 ASF or greater using the above described equipment. Typical current densities are in the range of 50 to 2000 ASF or higher, preferably 100 to 1500 ASF, and more preferably 200 to 500 ASF. Typically, such processes also operate above a temperature of about 70° F (21° C). Suitable temperatures include, but are not limited to, those in the range of 70° to 140° F (21° to 60° C) or higher, preferably greater than 85° F (29° C), and more preferably greater than 95° F (35° C).

The electrolyte compositions of the present invention are particularly suitable for tin electroplating of steel, particularly in high speed electroplating processes. When the compositions of the present invention are used in high speed tin plating of steel, the amount of tin is typically in the range of 5 to 50 g/L, and preferably 10 to 30 g/L. The acidic electrolyte is typically present in such compositions in an amount in the range of 20 to 80 g/L, and preferably 30 to 60 g/L. Current densities of 100 to 600 ASF are suitable for the high speed tin plating of steel according to the present invention. Suitable temperatures include, but are not limited to, those in the range of 70° to 140° F (21° to 60° C) or higher, preferably greater than 85° F (29° C), and more preferably greater than 95° F.

Such a method for high speed electroplating of tin or tin-alloys, such as on steel, includes the steps of: a) utilizing high speed electroplating equipment comprising an electroplating cell; an overflow reservoir adjacent the cell; means for returning solution from the reservoir to the electroplating cell; means for directing a substrate to be plated

from an entry point at one end of the cell to an exit at a second end of the cell; b) introducing an electrolyte including a basis solution of one or more tin compounds, one or more acidic electrolytes, one or more alkylene oxide compounds, one or more polyalkylene glycols and optionally one or more additives; and c) continuously electroplating substrates with tin or tin-alloy at a sufficient current density and at a sufficient temperature for high speed electroplating as the substrates pass through the electroplating solution within the cell.

The returning means may be any known means, such as tubes, hoses, conduits, pumps, drains and the like. The directing means may be any known means, such as conveyors, belts, rollers, robot arms and the like.

The high speed electroplating process of the present invention may be performed using any of a variety of high speed electroplating equipment. Such high speed electroplating equipment is well known to those skilled in the art, such as, for example, that disclosed in US Pat. No. 3,819,502, herein incorporated by reference to the extent it teaches such equipment. One typical apparatus utilizes an electroplating cell as shown in Fig. 1. This cell **100** includes a tank **110** for retaining the electrolyte **120** therein and tin anodes **130** for supplying tin to the electrolyte. Steel strip **140** passes around a conductor roll **150** and downwardly into the cell **110** between tin anodes **130**. As the strip **140** passes downwardly between the anodes **130**, a tin coating begins to deposit thereon. Thereafter, strip **140** passes around sink roll **160** located near the bottom of the cell **100** and then passes upwardly between additional anodes **130** for receiving additional tin deposition before exiting the cell. Thereafter, strip **140** passes around another conductor roll **150** and into an adjacent cell. A plurality of such cells are utilized in a tin-plate production machine to deposit the appropriate amount of tin coating on the steel strip.

Although not shown in the figure, the plating electrolyte is continuously circulated between the system and a storage tank. The solution is primarily pumped into the bottom of each cell. The solution in each cell is maintained at the appropriate level by the use of an overflow. Solution collected from the overflow is directed to the storage tank for recirculation.

After exiting the last cell, the strip passes through electrolyte recovery and rinsing stations. Recovered electrolyte is directed to the storage tank for recirculation. Rinsing is conducted in a second tank by a system of hot water sprays and wringer rolls. Finally, the tinplate is dried by passing through an air dryer to complete the electroplating operation. When a bright deposit is desired, the tinplate is subject to conventional reflow processing.

The following examples are intended to illustrate further various aspects of the present invention, but are not intended to limit the scope of the invention in any aspect.

Example 1

An electrolyte composition was prepared containing 15 g/L tin from tin methane sulfonate, 40 g/L free methane sulfonic acid, 1 g/L sulfuric acid, 0.5 g/L of an EO/PO copolymer having an average molecular weight of 2200, 0.5 g/L polyethylene glycol having an average molecular weight of 6000, and 0.25 g/L of a reducing agent. An electrolyte bath was prepared by combining the electrolyte composition with water to provide the desired volume.

A steel panel, 6" x 2.5" (15.24 cm x 6.35 cm), was wrapped around a conductive mandrel and rotated at a speed of 1500 rpm in the electrolyte at a temperature of 40° C. The panel was then electroplated using a current density of 300 ASF to deposit a tin coating approximately 50 microinches thick. The steel panel was subsequently rinsed, dried and the deposit was reflowed to produce a brilliant, reflective tin coating.

Example 2

An electrolyte composition was prepared containing 20 g/L tin from tin methane sulfonate, 30 g/L free methane sulfonic acid, 1 g/L sulfuric acid, 1.5 g/L of an EO/PO copolymer having an average molecular weight of 2200, 0.5 g/L of a polyethylene glycol having an average molecular weight of 14,000, and 1.0 g/L of a reducing agent. An electrolyte bath was prepared by combining the electrolyte composition with water to provide the desired volume and operated at a temperature of 130° F.

The electrolyte composition was placed in a Hull cell and a steel panel was electroplated using 3 amperes. The resultant panel had a smooth, uniform, matte tin deposit from the low current density edge to approximately $\frac{3}{4}$ " (1.9 cm) from the high current density edge.

Example 3

An electrolyte composition was prepared containing 50 g/L tin from tin methane sulfonate, 100 g/L free methane sulfonic acid, 1.0 g/L of an EO/PO copolymer having an average molecular weight of 2200, 1.0 g/L of a polyethylene glycol having an average molecular weight of 14000, 0.5 g/L of a reducing agent, and 0.1 g/L of a grain refiner. An electrolyte bath was prepared by combining the electrolyte composition with water to provide the desired volume and operated at a temperature of 110° F.

The electrolyte composition was placed in a Hull cell and a steel panel was electroplated using 5 amperes. The resultant panel had a smooth, uniform, matte tin deposit from the low current density edge to approximately $\frac{3}{4}$ " (1.9 cm) from the high current density edge.

What is claimed is:

1. A electrolyte composition for depositing tin or tin-alloy on a substrate, comprising one or more tin compounds, one or more acidic electrolytes, one or more alkylene oxide compounds, one or more polyalkylene glycols and optionally one or more additives.
2. The electrolyte composition of claim 1 wherein the tin compound is selected from tin halides, tin sulfates, tin alkane sulfonate, tin aryl sulfonate, or tin alkanol sulfonate.
3. The electrolyte composition of claim 1 wherein the tin compound is present in an amount in the range of from 5 to 100 g/L.
4. The electrolyte composition of claim 1 wherein the acidic electrolyte is selected from alkane sulfonic acids, aryl sulfonic acids, sulfuric acid, sulfamic acid, hydrochloric acid, hydrobromic acid and fluoroboric acid.
5. The electrolyte composition of claim 1 wherein the acidic electrolyte is present in an amount in the range of 10 to 400 g/L.
6. The electrolyte composition of claim 1 wherein the alkylene oxide compound is selected from ethylene oxide / propylene oxide block copolymers, alkylene oxide condensation products of an organic compound having at least one hydroxy group and 20 carbon atoms or less, or compounds prepared by adding oxypropylene to polyoxyethylene glycol.
7. The electrolyte composition of claim 1 wherein the alkylene oxide compound has an average molecular weight of from about 500 to about 10,000.
8. The electrolyte composition of claim 1 wherein the alkylene oxide compound is present in an amount of from 0.1 to 15 mL/L.
9. The electrolyte composition of claim 1 wherein the polyalkylene glycol is selected from polyethylene glycol or polypropylene glycol.
10. The electrolyte composition of claim 1 wherein the polyalkylene glycol has an average molecular weight of from about 200 to about 100,000.

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11. The electrolyte composition of claim 10 wherein the polyalkylene glycol is present in an amount of from 0.1 to 15 g/L.

12. The electrolyte composition of claim 1 further comprising water.

13. The electrolyte composition of claim 1 wherein the additives are selected from reducing agents, grain refiners, brightening agents and mixtures thereof.

14. A method for depositing tin or tin-alloy on a substrate comprising the steps of contacting the substrate with the electrolyte composition of claim 1 and applying a sufficient current density to the electrolyte composition to deposit the tin or tin-alloy on the substrate.

15. A substrate having a tin or tin-alloy deposited thereon according to the method of claim 14.

16. The method of claim 14 wherein the current density is in the range of 1 to 2000 ASF.

17. A method for high speed electroplating of tin or tin-alloys comprising the steps of: a) utilizing high speed electroplating equipment comprising an electroplating cell; an overflow reservoir adjacent the cell; means for returning solution from the reservoir to the electroplating cell; means for directing a substrate to be plated from an entry point at one end of the cell to an exit at a second end of the cell; b) introducing an electrolyte including a basis solution of one or more tin compounds, one or more acidic electrolytes, one or more alkylene oxide compounds, one or more polyalkylene glycols and optionally one or more additive; and c) continuously electroplating substrates with tin or tin-alloy at a sufficient current density and at a sufficient temperature for high speed electroplating as the substrates pass through the electroplating solution within the cell.

Abstract of the Disclosure

Disclosed are electrolyte compositions for depositing tin or tin-alloys at various current densities. Also disclosed are methods of plating such tin or tin-alloys on substrates, such as the high speed tin plating of steel.

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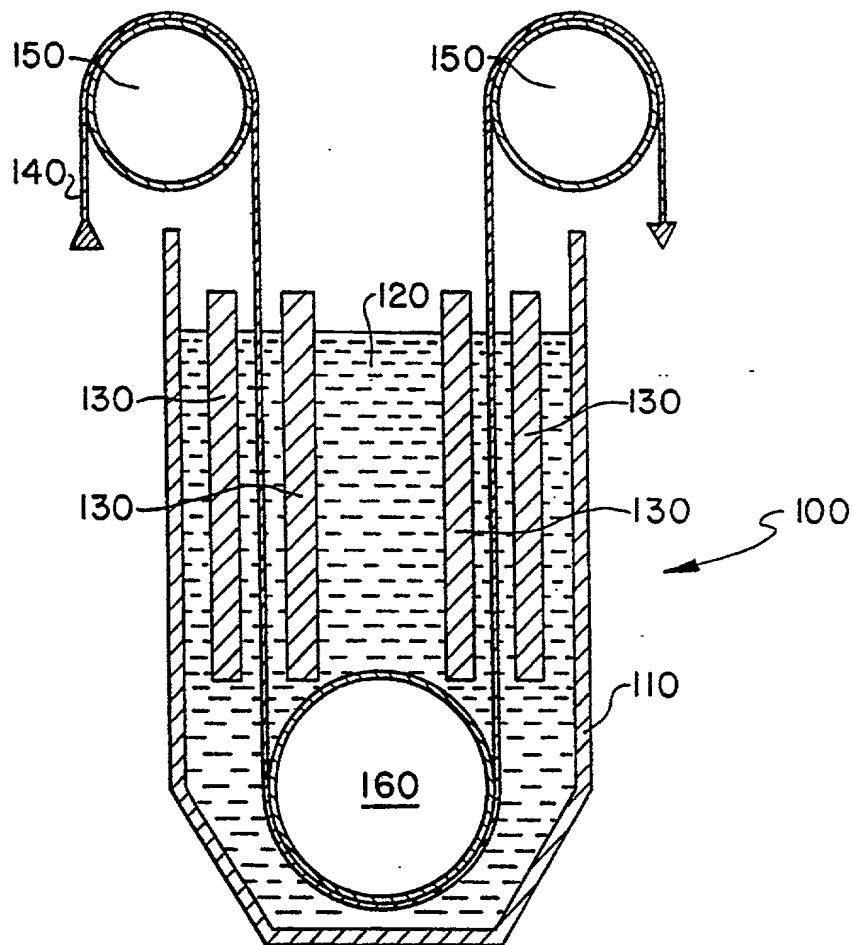


Fig. 1

Express Mail Label No.

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Docket No.

50694

Declaration and Power of Attorney For Patent Application

English Language Declaration

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name,

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

TIN ELECTROLYTE

the specification of which

(check one)

☒ is attached hereto.

☐ was filed on _____ as United States Application No. or PCT International Application Number _____ and was amended on _____ (if applicable)

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose to the United States Patent and Trademark Office all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, Section 119(a)-(d) or Section 365(b) of any foreign application(s) for patent or inventor's certificate, or Section 365(a) of any PCT International application which designated at least one country other than the United States, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate or PCT International application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application(s)

Priority Not Claimed

(Number)

(Country)

(Day/Month/Year Filed)

☐

(Number)

(Country)

(Day/Month/Year Filed)

☐

(Number)

(Country)

(Day/Month/Year Filed)

☐

I hereby claim the benefit under 35 U.S.C. Section 119(e) of any United States provisional application(s) listed below:

(Application Serial No.)

(Filing Date)

(Application Serial No.)

(Filing Date)

(Application Serial No.)

(Filing Date)

I hereby claim the benefit under 35 U. S. C. Section 120 of any United States application(s), or Section 365(c) of any PCT International application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of 35 U.S.C. Section 112, I acknowledge the duty to disclose to the United States Patent and Trademark Office all information known to me to be material to patentability as defined in Title 37, C. F. R., Section 1.56 which became available between the filing date of the prior application and the national or PCT International filing date of this application:

(Application Serial No.)

(Filing Date)

(Status)
(patented, pending, abandoned)

(Application Serial No.)

(Filing Date)

(Status)
(patented, pending, abandoned)

(Application Serial No.)

(Filing Date)

(Status)
(patented, pending, abandoned)

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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